Name _____ Class _____ Date _____

Mass and Mole Relationships in a Chemical Reaction

Experiment 11

Process Objectives

- To establish a control that allows you to determine the variables of the experiment.
- To experimentally determine the mole ratio of reactant and product.

Learning Objectives

- To calculate the number of moles of reactant and product in a simple chemical reaction.
- To investigate mass and mole relationships in reactants and products of a reaction.

Introduction

In this experiment, you will measure the mass of the solid reactant, $NaHCO_3$ and that of the solid product, NaCl. The experimental determination of these relative masses will enable you to determine their relative number of moles. As a result of your observations and calculations, you will determine the mass and mole relationships—the reacting ratios—of the solid reactant and product. Review Chapter 8, Section 8.1 and Chapter 9, Section 9.1 for additional information.

The ratios of masses and moles is important in kitchen chemistry also. In some recipes, baking soda, $NaHCO_3$, is used to cause a cake to "rise." When a weak acid such as vinegar, or buttermilk, or lemon juice is added to the baking soda, bubbles of carbon dioxide are produced. For example

$$\underset{\text{vinegar}}{HC_2H_3O_2} + \underset{\substack{\text{sodium}\\\text{bicarbonate}}}{NaHCO_3} \rightarrow H_2O + CO_2 + \underset{\text{sodium acetate}}{NaC_2H_3O_2}$$

This release of gas is what causes the cake to increase in size. However, because baking soda tastes bitter and acids taste sour, it is important to add them close to their reacting ratio so they will neutralize each other. This results in cakes and cookies that are neither bitter nor sour.

Safety

Take the necessary precautions before beginning this experiment. Wear safety goggles, apron, and gloves. Read all safety cautions in your procedures and discuss them with your teacher. It is important to use good safety techniques while conducting experiments. See pages 8 through 11.

Apparatus

balance, centigram
iron ring
graduated cylinder, 25-mL
burner and tubing
evaporating dish and watch glass
wire gauze, ceramic-centered
spatula
ring stand
eye dropper
sparker

Materials

sodium hydrogen carbonate
hydrochloric acid, 3 *M*

Strategy for Experimenting
In this experiment the ratio calculated from the laboratory data will probably not be exactly a whole number, but it should be close. You will need to examine your data and do some rounding-off to find the nearest whole number ratio.

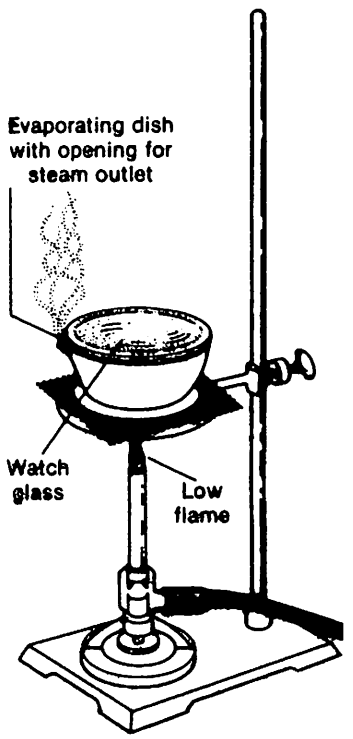

Figure 11-1

Recording Your Observations
After completing each procedure, record your observations in the Data Table at the end of the procedures.

Procedures

1. Place an evaporating dish on top of a watch glass. Measure the mass of the dry evaporating dish and the dry watch glass. Record this mass in your Data Table.
2. Add 2–3 g of sodium hydrogen carbonate to the evaporating dish. Measure the mass of the sodium hydrogen carbonate, evaporating dish, and watch glass. Record this mass in your Data Table.
3. Slowly add about 10 mL of hydrochloric acid to the sodium hydrogen carbonate in the evaporating dish. Then carefully add hydrochloric acid from the medicine dropper until the bubbling stops.

CAUTION Hydrochloric acid is caustic and corrosive. Avoid contact with skin and eyes. Avoid breathing vapors. Make certain that you wear safety goggles, apron, and gloves when working with acids. If any acid should spill on you, immediately flush the area with water and then notify your teacher.

4. Place the evaporating dish on the ceramic-centered wire gauze that has been placed on the iron ring attached to the ring stand. Place the watch glass concave side up on top of the dish, but tipped slightly so steam can escape. See Figure 11-1.
5. Gently heat the evaporating dish with a small flame until only a dry solid remains. Make sure no water droplets remain on the underside of the watch glass.

CAUTION Before you light the burner, check to see that long hair and loose clothing have been confined. Remember to allow all apparatus to cool before you handle it again.

6. Turn off the gas burner. Allow the apparatus to cool for at least 15 minutes. Determine the mass of the cooled assembly. Record the mass of the dish, residue, and watch glass in your Data Table.
7. If time permits, reheat the evaporating dish and contents for two minutes.
8. Rinse the residue down the sink. Wash your hands and check to see that the gas valve is turned off before leaving the laboratory.

Data Table

Mass of dish and glass	_____	g
Mass of dish, glass, and $NaHCO_3$	_____	g
Mass of dish, glass, and residue (NaCl) after first heating	_____	g
Mass of dish, glass, and residue (NaCl) after second heating	_____	g

Name_____

Stoichiometry Lab Data and Calculations Sheet

Data Table	
Mass of dish and watch Glass	g
Mass of dish, glass, and $NaHCO_3$	g
Mass of dish, glass, and NaCl after heating	g

Calculations

Show your calculations in the space provided. Make sure to show your work with units. Place your answers in the calculations table on the next page.

1. Write a balanced formula equation for the reaction that was performed in this lab.

2. Calculate the mass of the reactant, $NaHCO_3$.

3. Calculate the number of moles of $NaHCO_3$ reacted.

4. From the moles of $NaHCO_3$ that reacted, calculate the mass of NaCl that should have been produced. This is called the **theoretical yield**.

5. Calculate the mass of sodium chloride that was experimentally produced in the reaction. This is called the **actual yield**.

6. Calculate the percent yield from this reaction.

7. Give **specific** reasons about why your percent is not exactly 100%. Make sure to **fully explain** your answer.

Calculations Table	
Mass of $NaHCO_3$ reacted	g
Moles of $NaHCO_3$ reacted	mol
Theoretical yield of NaCl	g
Actual yield of NaCl	g
Percent yield of NaCl	%

Questions and General Conclusions

1. Define Theoretical Yield, Actual Yield, and Percent Yield.

2. **Explain** how the percent yield in this experiment could be over 100%.

3. When 10.2 g of barium chloride reacted with an excess of silver nitrate, only 14.5 grams of precipitate were produced. What is the percent yield for this reaction?

4. Baking powder consists of a mixture of baking soda and a substance called cream of tarter. Baking soda is sodium bicarbonate, $NaHCO_3$. In the production of carbon dioxide gas, baking powder acts very differently from baking soda. When water is added to baking soda, it just dissolves. But when water is added to baking powder, carbon dioxide gas is produced. What is the purpose of the cream of tarter in baking powder and how does it accomplish this purpose?